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A device for continuous or semi-continuous casting of metals

FIELD OF THE INVENTION

The present invention is related to a device for continuous or semi-continuous casting of metals. It comprises in particular an electromagnetic brake comprising at least two magnetic cores arranged on one side of a mould and attached thereto, and a yoke which is detachably connected to the two magnetic cores and interconnects them.

Electromagnetic brakes comprise arrangements for generation of a static, magnetic field generated through direct current or a magnetic field generated through permanent magnets or an alternating, low-frequency pulsating magnetic field in the liquid metal in a mould in a device for continuous or semi-continuous casting of metals. When the metal flowing in passes the field, the movement of the tap jet into the rest of the liquid metal is retarded by the field and the tap jet is split such that its impulse is weakened or ceases. The main principles for the function and the advantages with such electromagnetic brakes are well known since earlier.

The field of the invention includes in particular devices for casting of "slabs", where the mould has a rectangular cross section and opposite pairs of magnetic cores are arranged along the opposite long sides of the mould and connected to a yoke each.

BACKGROUND OF THE INVENTION AND PRIOR ART

According to prior art it is known to arrange electromagnetic brakes of the initially defined kind, where each magnetic core is divided into a front part being permanently arranged at the mould and a back part being detachably connected to the front part. Each back core part carries a coil and each of the coils is wound substantially parallel to the mould wall around the back magnetic core part. The front part of the magnetic core can have the shape of a plate or similar comprising a magnetic material and being permanently connected to the mould. The back part has a surface for abutment against the front part which has an area and a geometry which is adjusted to the area and the geometry of the front part which in its turn is depending on the size of the mould among other things.

A drawback with prior art devices is that they require individual adjustment of the magnetic core part around which the coils are wound for different moulds of different size and the shape and size of the magnetic cores which are used differ from case to case.

Prior art magnetic cores in addition take up a relatively large space in a direction perpendicularly out from the mould wall.

THE OBJECT OF THE INVENTION

An object of the present invention is to provide a device for continuous or semi-continuous casting of metals comprising an electromagnetic brake, which is designed such that it simply can be adjusted to different mould sizes. In addition, the yoke and the magnetic cores shall be arranged in a way such that a compact brake, which extends as little as possible from the mould wall, is achieved, for enabling access of devices situated under the brake, for instances lifting devices.

At least a part of the yoke shall furthermore be easy to mount and dismount from the magnetic cores arranged at the mould.

SUMMARY OF THE INVENTION

The object of the invention is achieved by means of a device of the initially defined kind, being characterized in that the yoke carries a coil and that the coil is wound around the yoke substantially between the two magnetic cores interconnected by the yoke. The placement of the coil on the yoke results in that some magnetic core parts do not need to carry any coil and be limited by the coil in the same way as with prior art devices. They can easily be extended or shortened in the longitudinal direction of the yoke, that is along the width of the mould.

The mould is preferably rectangular transversal to the casting direction and has two opposite long sides, along one of which the yoke extends substantially parallel thereto, and the coil is preferably wound around the yoke such that the centre axis of the coil is substantially parallel to said long side and extends perpendicularly to the casting direction in the mould. Such an arrangement is advantageous from a space saving point of view and in addition leads to that the coil, or the part of the yoke around which the coil is wound, can be made easily accessible and exchangeable but can also give access to devices placed under the brake, for instance lifting devices. Preferably, the magnetic cores are arranged with a space therebetween, the coil being positioned substantially right in front of said space. The coil can with advantage be allowed to push into said space in order to save space.

According to a preferred embodiment of the device, the yoke comprises a portion, which is detachable from the rest of the yoke and carries the coil. Preferably, the yoke comprises two yoke parts, arranged on opposite sides of said portion, forming a cradle in which said yoke portion can rest and having a surface

each adapted to abut against a respective magnetic core. The cradle defined by said yoke parts is preferably arranged to allow a displacement of the coil carrying portion substantially vertically out of said cradle in order to facilitate exchange and maintenance of the coil or parts of the device being located vertically under the coil and which would otherwise be hard to access. The yoke parts which are arranged on opposite sides of the coil carrying yoke portion can easily be adjusted to different mould widths, or more particularly magnetic core widths, by adjustment of their length.

A further object of the invention is to provide a yoke, which is constructed such that the electromagnetic brake can easily be adjusted to different mould widths without the coil or the coils arranged on the brake constituting any substantial obstacle of such an adjustment. Furthermore, the yoke shall be designed according to a principle, which favours a very little space consuming construction of the electromagnetic brake of which the yoke is a part.

This object is achieved by means of a yoke according to the preamble of patent claim 13, which is characterized in that it carries a coil being wound around the yoke substantially between said surfaces. Said surfaces are two separate surfaces of the yoke which are adapted to detachably abut against one magnetic core each of two magnetic cores arranged at a mould. The yoke is moreover preferably arranged and designed in the way described above with reference to the device according to the invention.

Further advantages and characteristics of the invention and the yoke according to the invention will appear from the following description and the appended patent claims.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred embodiment of the device according to the invention will hereinafter be described as an example more in detail with reference to the appended drawing, on which:

Fig 1 is a schematic view from above of the device according to prior art,

Fig 2 is a schematic, cross section view from above of the device according to the invention,

Fig 3 is a schematic, cross section view according to III-III in Fig 2, and

Fig 4 is a schematic, cross section view according to IV-IV in Fig 2.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

Fig 1 shows a prior art device for continuous or semi-continuous casting of metals, the device comprising an electromagnetic brake 1. The device furthermore comprises a copper mould 2 of a kind known per se on opposite sides of which the electromagnetic brake 1 is arranged. The electromagnetic brake 1 comprises a number of magnetic cores 3, 4, 5, 6 connected to the mould wall. The magnetic cores 3-6 are arranged in pairs on opposite sides of the mould along the long sides 7, 8 thereof and cover substantially the entire width of the mould except for a centre portion of the mould. The magnetic cores 3, 4 and 5, 6, respectively, of each magnetic core pair are connected by means of a yoke 9, 10.

The magnetic cores 3, 4 and 5, 6, respectively, are welded into windows in so called backup plates 11, 12 made from stainless

steel and forming support walls for the copper sheets of the mould.

Each magnetic core 3-6 comprises a magnetic core part 14-17 carrying a coil 18-21. The coil carrying magnetic core parts 14-17 are preferably detachably connected to front magnetic core parts, being welded into the windows in the backup plates 11, 12. The yokes 9, 10 are detachably connected, for instance fastened by bolts, at the magnetic cores 3, 4 and 5, 6, respectively. The coils 18, 19, 20, 21 are wound substantially parallel to the mould wall around the back magnetic core parts 14, 15 and 16, 17, respectively.

When a current flows through the coils 18, 19, 20, 21, a magnetic field is obtained with a direction being indicated through the arrows in Fig 1.

Figs 2-4 show an embodiment of the device according to the invention, which shows an improved further development of the device according to Fig 1. As in the device according to Fig 1, the device according to the invention comprises an electromagnetic brake 24, comprising two pairs of magnetic cores 25, 26 and 27, 28, respectively, arranged along opposite long side walls 29, 30 of a copper mould 31 known per se. The magnetic cores 25-28 are arranged in a way corresponding to Fig 1 and serve to contribute to a generation of a magnetic field similar to the one described for the device according to Fig 1. However, the magnetic cores are not divided into front and back parts, where the back parts carry coils, which is the case in Fig 1.

The magnetic cores 25, 26 and 27,28, respectively, of each magnetic core pair are connected by means of a yoke 32, 33. Each yoke 32, 33 comprises a portion 34, 35, on which a coil 36, 37 is wound, each such portion being positioned substantially right in front of a space between the two magnetic cores 25, 26

and 27, 28, respectively, interconnected by the yokes 36, 37. The yokes are detachably connected to the magnetic cores.

On opposite sides of the coil carrying portion 34, 35, the yokes 32, 33 comprise two further parts 38, 39 and 40, 41, respectively, forming a cradle for the coil carrying portion 34, 35 and having surfaces 46-49 for abutment against the respective magnetic cores 25-28. The coil carrying portions 34, 35 are detachably attached, here fastened by bolts from above, to the further parts 38, 39 and 40, 41, respectively. The cradle defined by the further parts 38, 39 and 40, 41 is such that it allows displacement of the coil carrying portions 34, 35 substantially vertically upwards. In that way the coils 36, 37 can be easily dismounted and exchanged if required. The coil carrying portions 34, 35 can have the shape of a circular or square bar of magnetic material, around which the coils 36, 37 are wound.

The yokes 32, 33 furthermore comprise a number of pivoted portions 42-45, here being arranged to be pivoted substantially horizontally to enable access of parts of the device being situated under the electromagnetic brake 24 and which may need to be accessed for exchange and maintenance. The pivoted parts 42-45 form part of the parts 38-41 described above which are arranged on opposite sides of the coil carrying portions 34, 35 and connected thereto.

Typical parts included in the device and situated under the electromagnetic brake 24 and which must be made accessible are for instance lifting devices for lifting the mould with underlying segments, and parts requiring exchange and maintenance, for instance cylinders which are used for control of the metal string being continuously cast by means of the device.

The yokes 32, 33 could comprise further parts or portions, but the proposed solution is sufficient for enabling a fast and simple adjustment of the yoke size to different mould widths, that is

magnetic core widths. Suitably the coil carrying portions 34, 35 have a standard size and the length of the further parts 38-41 is adjusted with reference to the width of the mould/magnetic core.

It is to be understood that the device according to the invention normally comprises a large number of further components which, however, for the sake of clarity not have been shown in the appended drawings. Examples of such components are cooling loops arranged around the mould, as well as different components arranged around the electromagnetic brake and limiting the space, which the electromagnetic brake can be allowed to occupy. An idea of the invention is that yokes of the kind according to the invention shall be possible to be supplied to already existing devices for continuous or semi-continuous casting of metals and be mounted thereon, without any complicated adjustment of the brake which the yoke is part of being required on each single occasion.

The yokes 32, 33 preferably have the shape of bars or plates. The coil carrying portions 34, 35 can be supplied separately to a user of a device for continuous or semi-continuous casting of metals, who then easily cuts and shapes the further parts 38-41 himself from a suitable bar material.

The yokes 32, 33, the magnetic cores 25-28 and the coils 36, 37 are arranged to generate a static magnetic field generated through direct current or a magnetic field generated through permanent magnets or an alternating, low-frequency pulsating magnetic field in the liquid metal in the mould of the device.

A plurality of variants and alternative embodiments of the device according to the invention will of course be apparent for a man skilled in the art without departing from the scope of the invention, such as this is defined in the appended claims with support from the description and the drawings.

For instance the further yoke parts 38-41 situated on the side can just as well be considered as back magnetic core parts being detachably connected to the front magnetic core parts, here the cores 25-28, being permanently attached to the mould. However, it is important to note that existing coils 36, 37 only are mounted on yoke parts, of which the size and shape, at least over the cross section where the coil is arranged, are substantially independent of the mould size and the area of the magnetic cores against the copper wall of the mould.

Yokes and magnetic cores are all made of a magnetic material, preferably iron.